SHMS Tracking

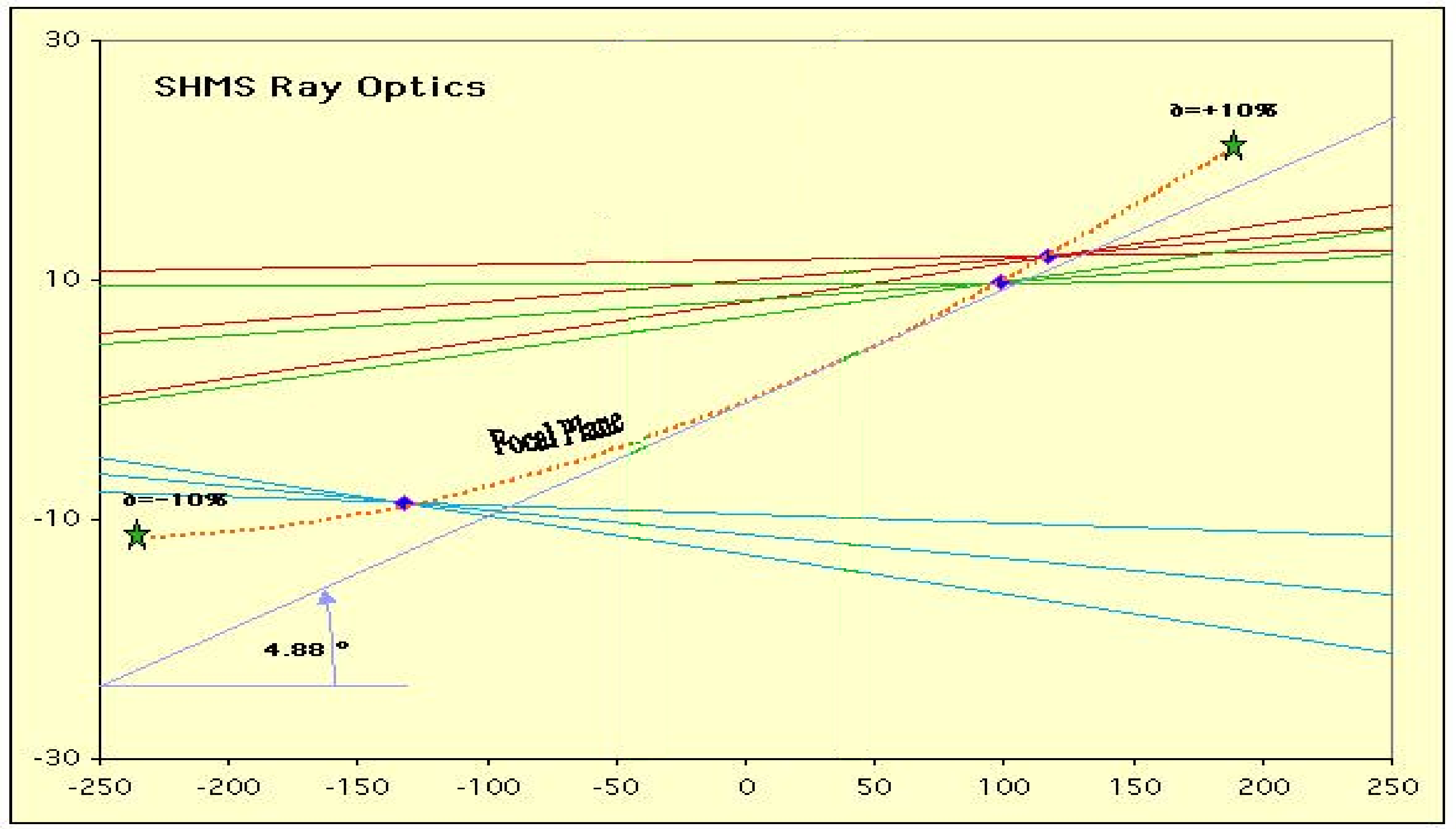
Choice and Design of Tracking System must be matched to physics requirements and practical considerations.

- Size / Coverage
- Resolution
- Rate
- Multiple tracks??
- dE/dx - Particle ID??
- Allowable material (MCS)
- Co$t
- Re-use of existing?

Performance Requirements

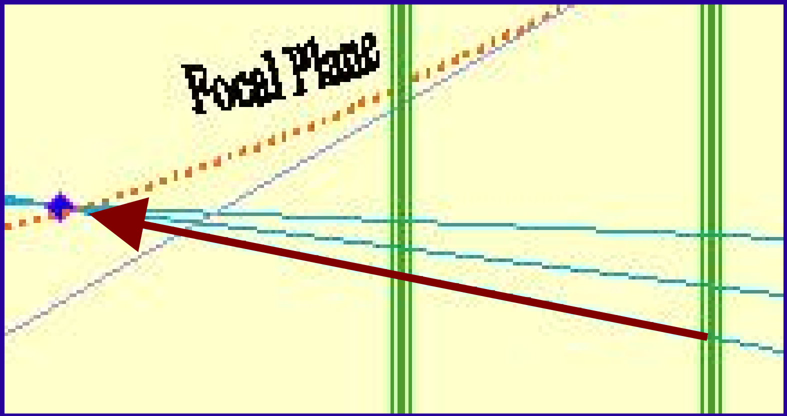
Resolution	*Physics*
Momentum	0.2%
Angle	1-2 mrad
Active Area	+–10% and 84x28 $mrad^2$
Max Rate	??
Material	< ~ 1% X_0

Focal Plane Optics



Focal Plane Optics

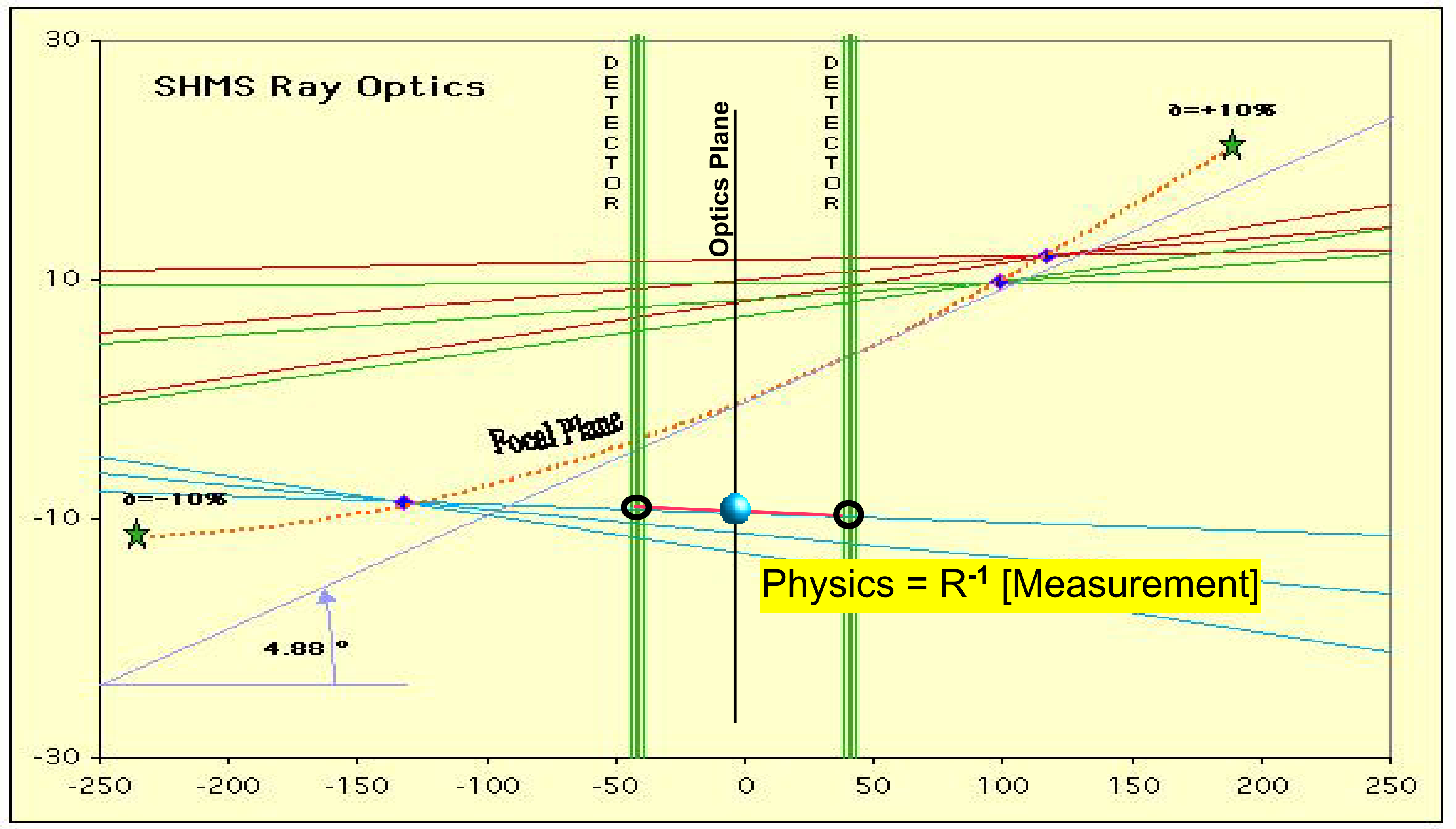
- Momentum Resolution is determined by how well we can project track onto focal plane.
- Unrealistic to put detector in the focal plane
  - too long and not flat
  - small angle means track sees lots of material



Focal Plane Optics

- Instead, make precise measurements in practical detectors
  - roughly perpendicular to tracks, so they are thin
  - with adequate precision for projection to FP
  - with adequate extension to provide angular resolution
- From measurements, get track vector at convenient optical plane
  - two space points OR two track segments $\Rightarrow$ track vector
- Then, get physics quantities at the target
  - apply inverse transport matrix

Focal Plane Optics



Performance Parameters

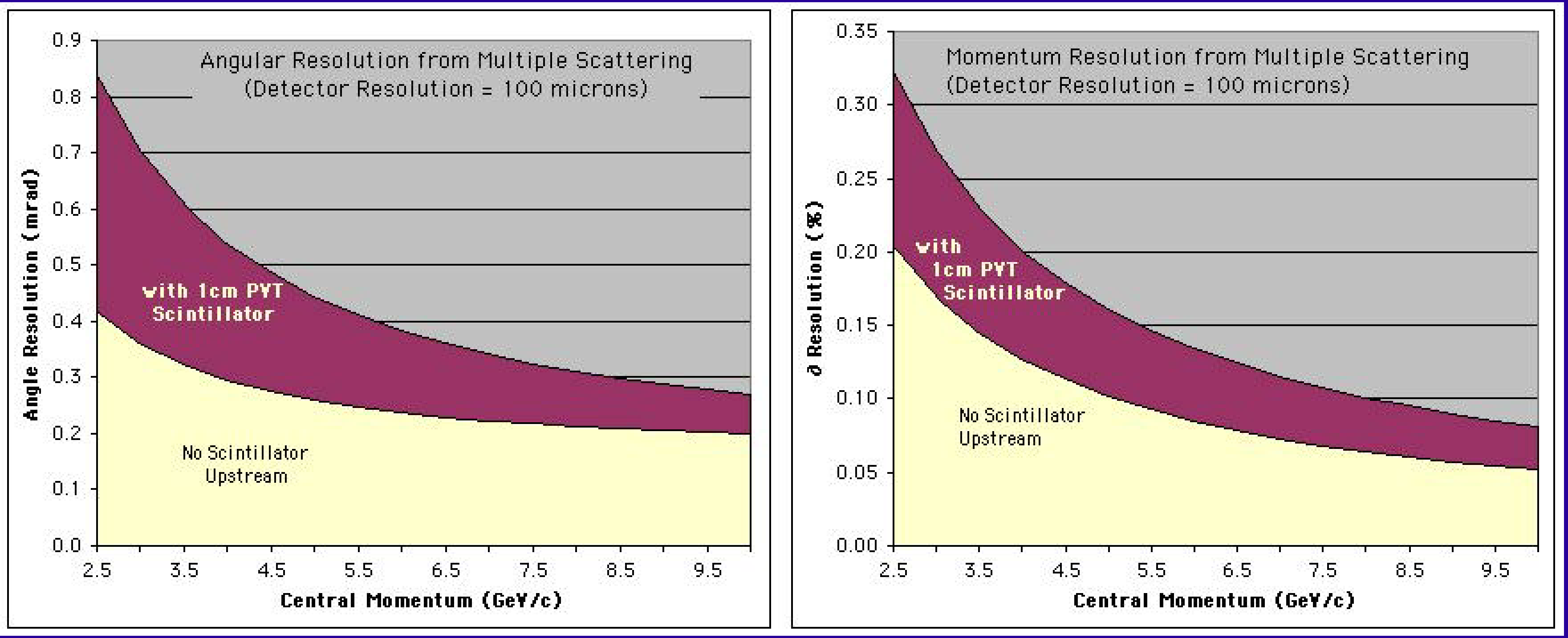
Resolution	*Physics*	*Detector*
Momentum	0.2%	~100 microns combined
Angle	1-2 mrad	800 microns over 80 cm
Active Area	+–10% and 84x28 mrad^2	25x50 cm^2 (horiz. x vert.)
Max Rate	??	100 kHz/cm wide stripe
Material	< ~ 1% X_0	Thin!

Detector Options

Parameter	Resolution	Rate	Material	Lifetime	Notes
	(microns)	$/s\cdot cm^2$	x/X_0	years	
Requirement	100	100 kHz	< 1%	10	
SOS Drift Ch.	100	1 MHz/wire	0.20%	ok	2x6 planes, $\perp$ to central ray
Silicon Strips	20	1MHz/strp	1.80%	??	2x2 planes (x,y)
CSC	<100		~5%	ok	2x double plane
GEM	<100	10^5	~5%	??	
SciFi	500	1MHz/fiber	2.50%	ok?	2x2 planes+1 in FP (no!)

Importance of MCS to Resolution

Look at impact of adding just 1cm PVT scintillator upstream



Certainly at low momentum, resolution is dominated by Multiple Coulomb Scattering. (1cm PVT = 2.4% X_o)

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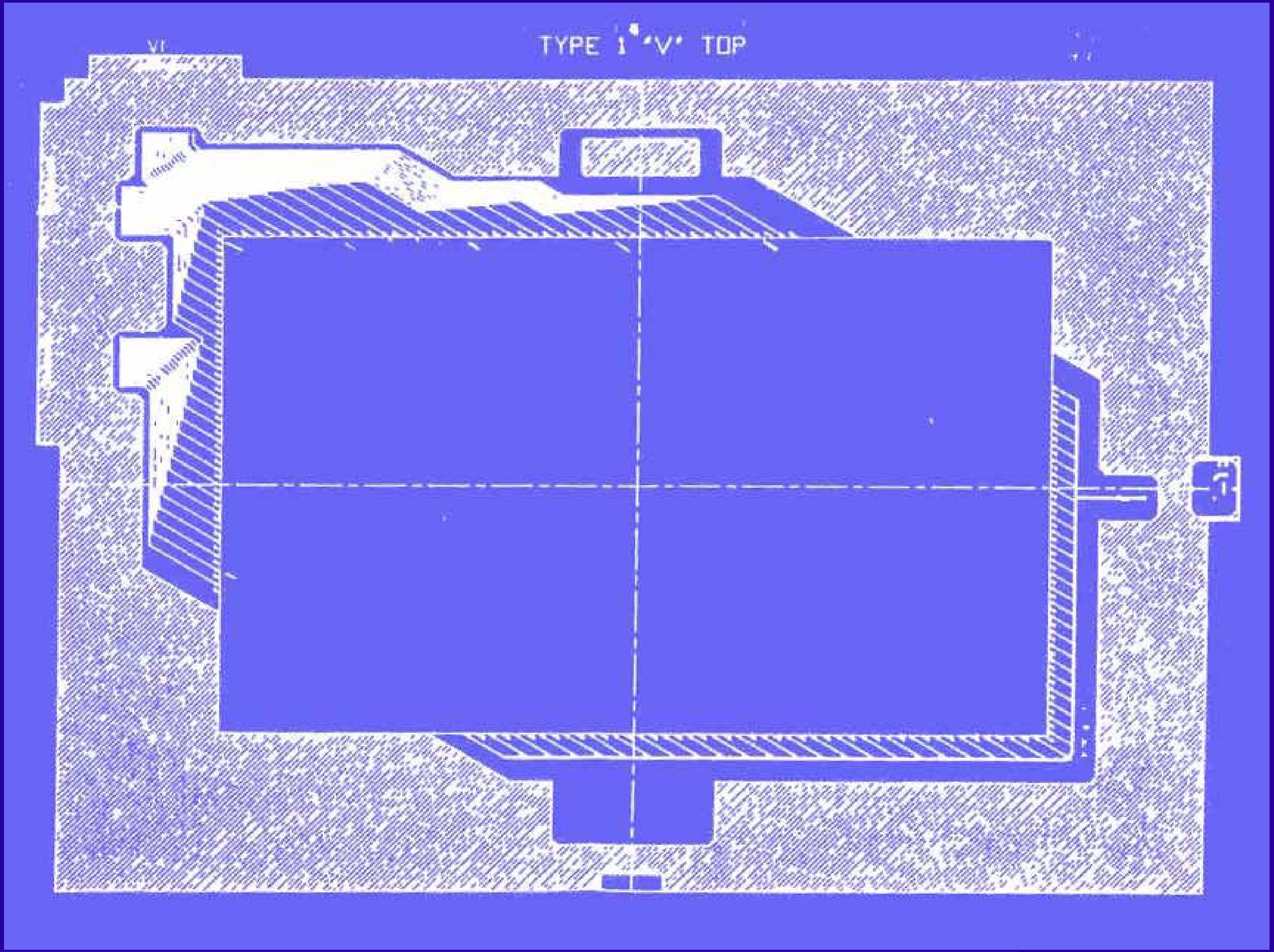
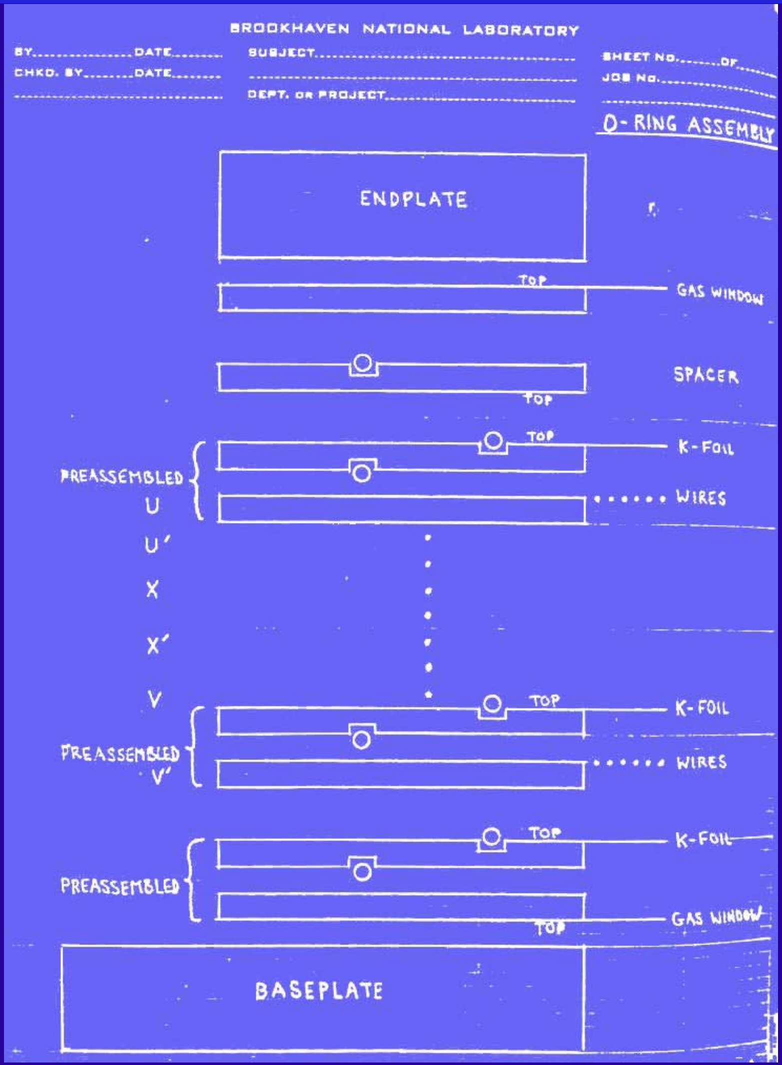
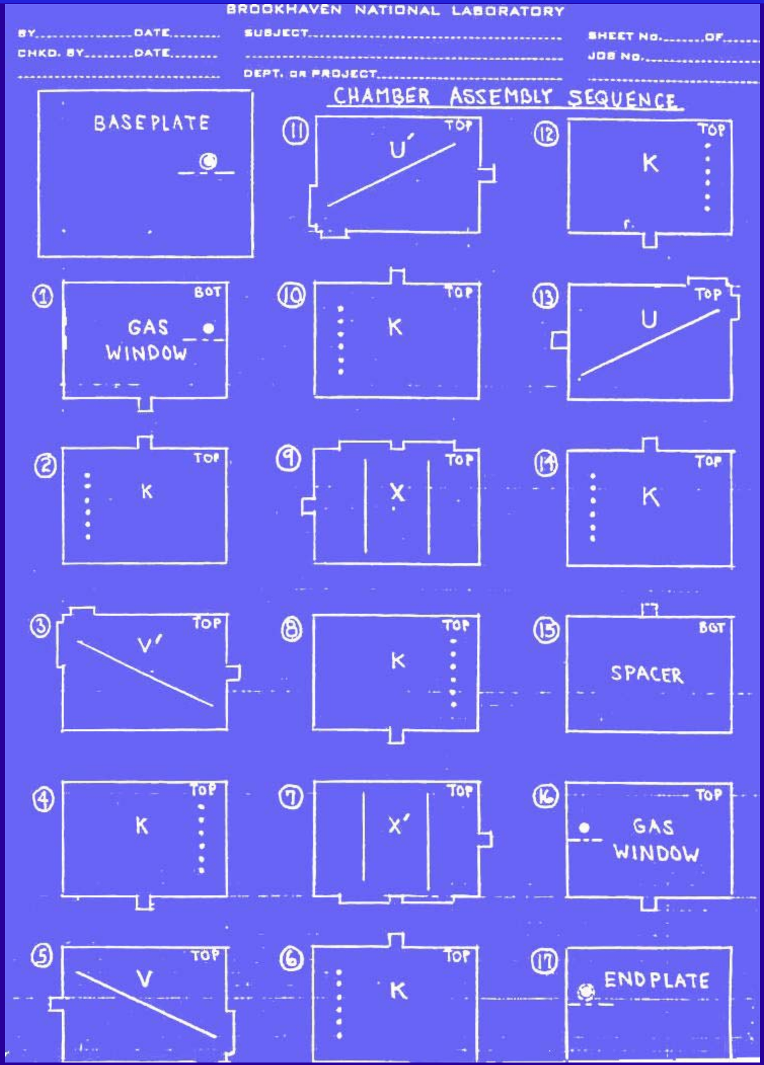
SOS Chamber Anode Plane



SOS Chamber Stack





Cost Estimating

Wire Chamber Cost Estimate

Electronics	Mechanical	*Qty*	*Unit Cost*	*Labor*	*Total*
Power Supplies	Frames				
Low Voltage	Alignment				
High Voltage	Wire Planes				
Threshold	Windows				
Readout	Cable Support				
Amp/Disc	Racks				
TDC	Wire				
Crate	Gas				
Controller	Mixing				
Cables	Metering				
Signal	Storage				
High Voltage	Control / Monitor				
Low Voltage	Plumbing				
Control	Safety				
Readout	Haz. Gas				
Threshold	Signage				
Misc	HV Protection				
Connectors	LV Protection				
Low Voltage	Interlocks				
High Voltage	Installation				
Signal	Fixtures				
Logic	Rigging				

Cost Estimate - 1st Pass

(no explicit labor included)

	Cost Rollup			
1.0.0.0	**Wire Chamber Cost Framework**			**$226,260**
1.1.0.0	**Electronics**		**$146,560**	
1.1.1.0	Power Supplies	**$12,060**		
1.1.2.0	Readout	**$128,500**		
1.1.3.0	Cables (terminated)	**$5,010**		
1.1.4.0	Connectors	**$990**		
1.2.0.0	**Mechanical**		**$79,700**	
1.2.1.0	Chambers	**$49,700**		
1.2.2.0	Gas System	***$20,000***		
1.2.3.0	Safety	***$5,000***		
1.2.4.0	Installation	***$5,000***		

Conclusions

- ✓ Performance requirements and material budget lead to the choice of a gas drift chamber.
- ✓ SOS-style (stack-up) chamber design is known to meet the SHMS needs and is relatively easy to construct. Starting plans exist. Cost ~ ¼ $M.
- ✓ To take advantage of the spectrometer and detector resolutions, the material budget must be strict and must be adhered to.